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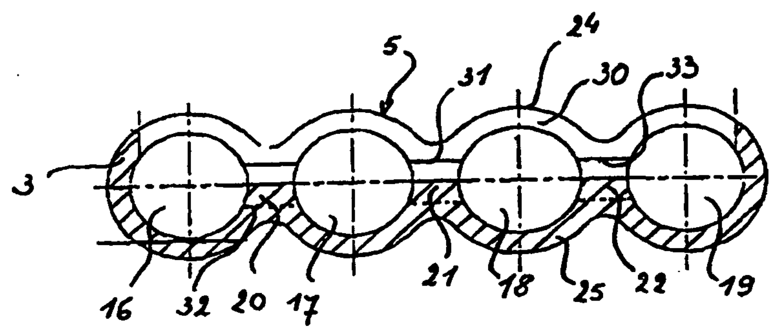
(54) Title: HEAT EXCHANGER

(57) Abstract

A heat exchanger comprises a plurality of flat tubes (1) for heat exchange between a first fluidum flowing inside said tubes (1) and a second fluidum flowing outside of said tubes (1). A pair of hollow headers (3, 4) is connected to the end of the flat tubes (1) an inlet (6) and an outlet (7) being provided in the headers (3, 4) for introducing the first fluidum into the flat tubes and discharging it therefrom. Each header (3, 4) is composed of at least two parallel tubes (16, 17, 18, 19) with substantially circular cross section, two adjacent tubes having integrated wall portions (20, 21, 22), thereby providing a substantially flat header (3, 4).



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HEAT EXCHANGER

The invention relates to a heat exchanger comprising a plurality of flat tubes for heat exchange between a first fluid flowing inside of said tubes and a second fluid flowing outside of said tubes, a pair of hollow headers connected to the respective ends of the flat tubes, an inlet and an outlet being provided in the headers for introducing the first fluid into the flat tubes and discharging it therefrom.

Such a heat exchanger is known from EP-A-0359358.

In the known heat exchanger, the headers consist of tubes with a circular cross-section. These tubes have been provided with holes with a shape corresponding to the cross-section of the heat transfer tubes so as to accept the tube ends. This design proves to be very satisfactory with the traditional pressures used in this type of heat exchanger. Commonly at the low pressure side a pressure of 2,5-6 bar has been used, whereas at the high pressure side pressures between 15 and 30 bar are used. With the introduction of higher pressures, the wall thickness of the header has to be increased. This is especially true for heat exchangers using CO_2 at high pressure, where the low pressure is between 35-80 bar and the high pressure between 80 and 170 bar.

This increase in size of the headers has resulted in heat exchangers with large size and weight, which constitutes especially a disadvantage in heat exchanger to be used in mobile equipment such as passenger cars and the like.

It is therefore an object of the invention to provide a heat exchanger which does not show the disadvantages mentioned above.

This and other objects are achieved in that each header is composed of at least two parallel tubes where two adjacent tubes have common wall portions.

By shaping the headers in this way, it is possible to reduce the size and mass of the header considerably, especially if compared with the traditional circular header.

By composing the header of a number of parallel tubes of circular cross-section, it is possible to use lower wall thickness as the strength of such tubes with small diameter is much higher than tubes with large diameters. Moreover, the internal volume of the header has been reduced, and results in less use of heat exchanging fluid in the heat exchanger.

Other advantages and characteristics of the invention will become clear from the following description, references being made to the annexed drawings. In the drawings

Fig. 1 is schematic view of a heat exchanger according to the invention,

Fig. 2 is a cross-section according to the line II-II of the header, shown in Fig. 1,

Fig. 3 is a front view of the header used in the heat exchanger of Fig. 1,

Fig. 4 is a side view of the header of Fig. 3 and

Fig. 5 a front view of the header on enlarged scale according to Fig. 3, showing one hole in more detail.

Referring to Figs. 1 to 4, the illustrated heat exchanger includes a plurality of flat heat transfer tubes 1 stacked in parallel and corrugated fins 2 sandwiched between the flat tubes 1. The ends 1a of the tubes 1 are connected to headers 3 and 4. Each heat transfer tube may be made of extruded aluminium, having a flat configuration. Alternatively, the flat tubes can be multi-bored flat tubes, commonly called multiport tubes or else, electrically seamed tubes can be used. Multiport tubes may be made by extrusion, but otherwise it is possible to make such tubes by rolling from clad sheet, folding and brazing. Furthermore, it is possible to use a welded tube with an inserted baffle.

In the embodiment shown each corrugated fin 2 has a width approximately similar to that of the flat tube 1 but other widths may be used as well. The fins 2 and the flat tubes 1 are brazed to each other. The headers 3,4 are made up of aluminium tubes with holes 5 of the same shape as the cross-section of the heat transfer tubes 1 so as to accept the tube ends 1a. The holes 5 can also be tailor made, e.g. conical, so as to allow easier access

for the flat tubes. The inserted tube ends 1a are brazed in the holes 5. As shown in Fig. 1, the headers 3 and 4 are connected to an inlet manifold 6 and an outlet manifold 7, respectively. The inlet manifold 6 allows a heat exchanging fluid to enter the header 3, and the outlet manifold 7 allows the heat exchanging fluid to discharge. The headers 3 and 4 are closed with caps or plugs 8 and 9, respectively. The reference numerals 13 and 14 denote side plates attached to the outermost corrugated fins 2.

The header 3 has its inner space divided by a baffle 10 into two sections, and the header 4 is divided into two sections a baffle 11. In this way a medium path is provided starting from header 3, passing through a first set of tubes 1, through part of the header 4, passing through a second set of tubes 1 to header 3 and passing through a third set of tubes 1 to header 4 and to leave the heat exchanger unit through outlet 7. It is clear that these headers without baffles are also possible and otherwise headers with more than one baffle per header can be applied as well.

The heat exchanging fluid flows in zigzag patterns throughout the heat exchanger unit

The headers 3 and 4 are basicly identical and in the figures 2 - 4 an example of a header 3 is shown in more detail. The header 3 consists in fact of a multiple port extruded tube and in the example shown four channels 16, 17, 18 and 19 are present. It is however clear that any number of channels may be present. The header 3 can be seen as being a number of tubes each forming one of the channels 16, 17, 18 and 19 and having wall portions 20, 21 and 22 which are common to two of these tubes. So the wall portion 20 is common for tubes forming the channels 16 and 17, the wall portion 21 for the tubes forming the channels 17 and 18 and the wall portion 22 for the tubes forming the channels 18 and 19. The wall portions 24 and 25 of the tubes which are more ore less perpendicular to the common wall portions 20, 21 and 22 are substantially in one plane and thereby form a substantially flat surface.

As more clearly shown in the figures 3 and 4, the wall portion 24 of the header 3 is provided with a number of holes 5. These holes 5 have a cross-section which substantially correspond to outer-dimensions and shape of the cross-section of the flat tubes 1. These holes can be obtained by means of serrations or cut-outs. As shown in figure 2 these holes extend to a defined depth reaching the common wall portions 20, 21 and 22 where they end in a common flat surface 31. The end portions 1a of the tubes 1

can be inserted to that depth into the holes 5 and can be connected to the header 3 by one of the commonly known methods such as brazing. In this way a fluid connection can be obtained between the header 3 and the individual tubes 1. Preferably each hole is made with increased depth by adding material to the header.

In case the tube ends 1a of a multiple port extrusion tube are fully inserted up to the level of the surface 31 into the header 2, a number of channels of this multiple port extrusion tube are blocked by the wall portions 20, 21 and 22 and are not effective in the heat transfer process. It is possible to use a number of multiple port extrusion tubes fitting into each cut-out in front of the open part of the channels 16, 17, 18 and 19. As a rule this is cumbersome and preference is given to an obstruction of the channels in the multiple port heat transfer tube 1 which are opposite the wall portions 20, 21 and 22.
Alternatively it is possible to increase the depth of the holes 5 up to the level of the surface indicated by 32. If the tubes 1 are now inserted up to the level of the surface 31 and fixed in that position a connection is obtained between the different channels 16, 17, 18 and 19 in the header 3. This may equalize the pressure and flow pattern between the different channels.

In order to facilitate the assembling and as shown in Figure 5, it is possible to make the holes 5 in two stages. In a first stage the hole 5 is made on full width i.e. the thicknes of the flat tubes 1, up to the level of surface 31. In a second stage the holes are made deeper on a reduced width i.e. appoximately the thickness of the flat tubes minus twice the wall thickness, up to the level of surface 32. As shown in Figure 5 in this way a number of shoulders 33 is made in the header holes, allowing the tubes ends 1a to be inserted up till the level of surface 31 and being connected to the header, thereby having an open communication between the different channels of the header 3 or 4, and thus allowing a better cross-flow pattern between the channels.

The shoulders 33 have a defined length corresponding to the thickness of common wall 20, 21 or 22 between the different channels of the header 3 or 4, as seen in Figure 2 and 5. In case of connecting the tubes 1 with the headers 3 or 4 be means of brazing, it is possible that part of the brazing material is flowing on the surface of the shoulder 33 and into the inner channel of the tubes 1. In order to avoid this in-flow of brazing material it is

possible to reduce the length of the shoulders to such an extent that only a very small portion of shoulder 33 is in contact with the tube end 1a.

It is clear that the invention is not restricted to the example described above but that modifications are possible within the same inventive concept which fall within the scope of the annexed claims. More especially it is possible to use two different headers, one with the tubes 1 fully inserted and one with the tubes 1 partially inserted in order to have the internal communication.

CLAIMS

1. A heat exchanger comprising a plurality of flat tubes for heat exchange between a first fluid flowing inside said tubes and a second fluid flowing outside of said tubes, a pair of hollow headers connected to the end of the flat tubes, an inlet and an outlet being provided in the headers for introducing the first fluid into the tubes and discharging it therefrom, characterised, in that each header is composed of at least two parallel tubes, where two adjacent tubes having common wall portions.

2. Heat exchanger according to claim 1, characterised in that the headers consist of a number of tubes with circular cross-section and constitutes a substantially flat array of tubes.

3. Heat exchangers according to claim 1 or 2, characterised in that a serrated edge like hole is made in one side of the flat surface of the header.

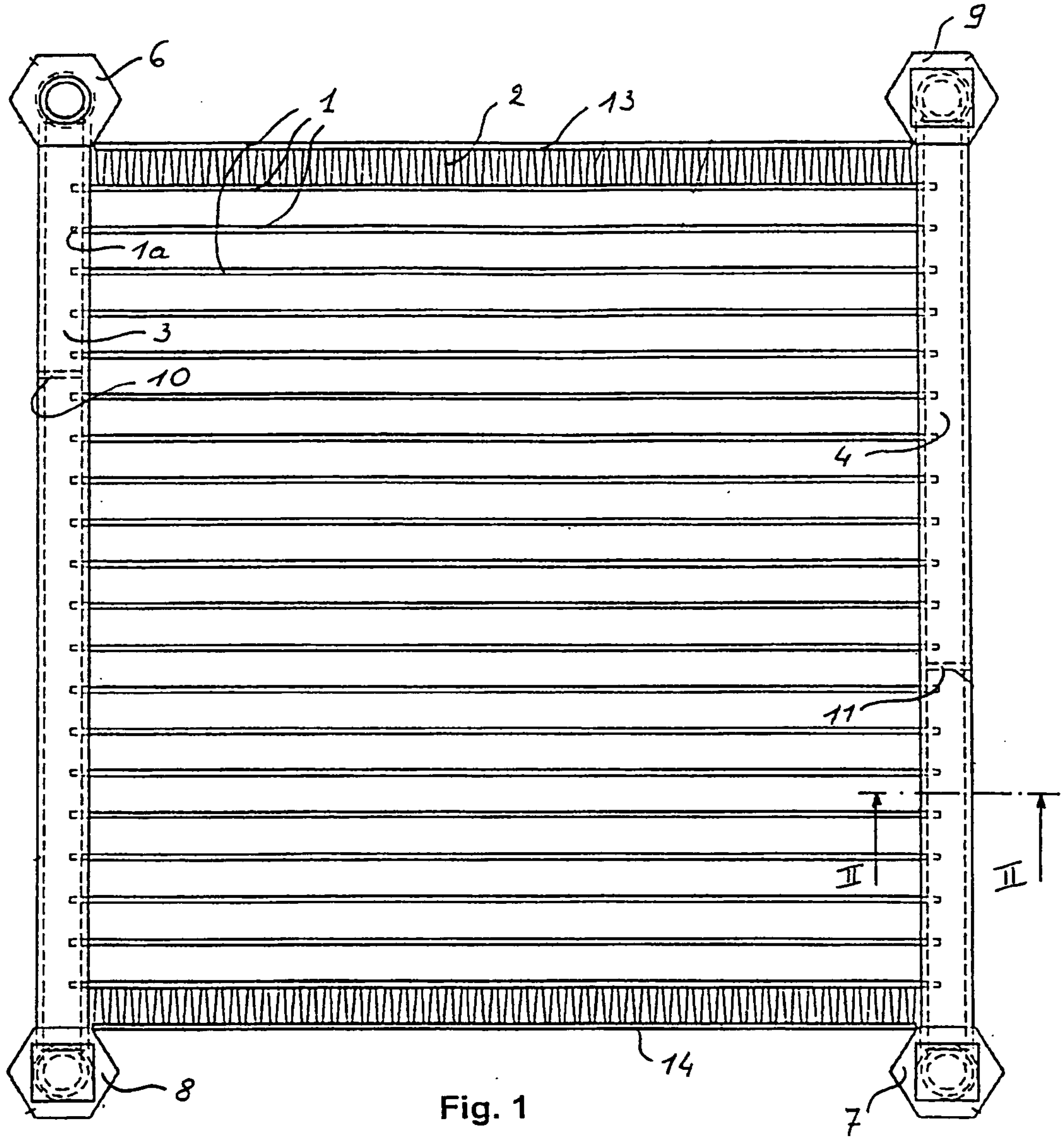
4. Heat exchanger according to any of the claims 1-3, characterised in that the tubes are only partly inserted into the circular tubes, thereby leaving a communication passage between the parallel tubes constituting the header.

5. Heat exchanger according to any of the claims 1-4, characterised in that the tubes are multiple port extruded tubes.

6. Heat exchanger according to claim 5, characterised in that the channels in the port heat transfer tube, opposing a wall portion in the header are blocked.

7. Heat exchanger according to claim 3 and 5, characterised in that the hole is made with a defined depth in the flat array of circular tubes, and in that the heat transfer tube is only inserted over a lesser depth.

8. Heat exchanger according to claim 7, characterised in that the hole is made with increased depth by adding material to the header.


6
9
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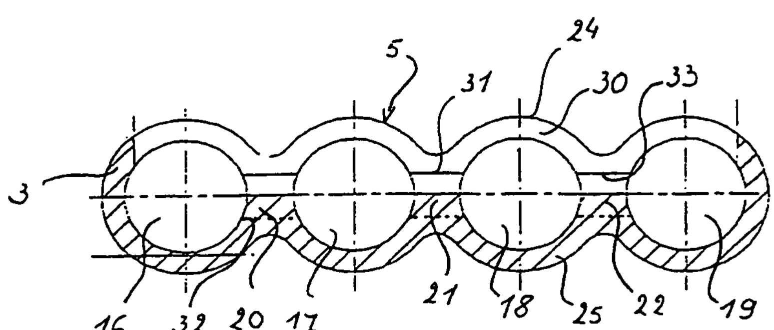
2
13
1a
3
10
4
11
II
II
8
14
7

Fig. 1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19

Fig. 2

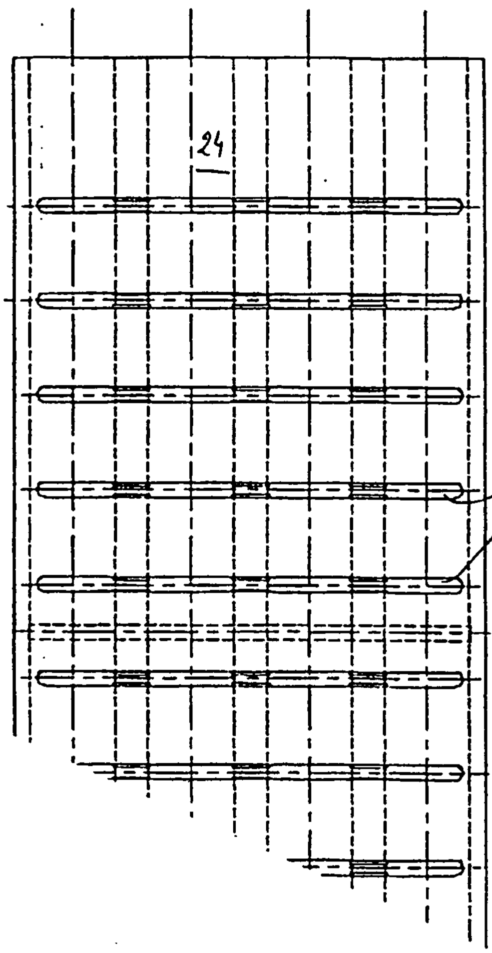

Fig. 3

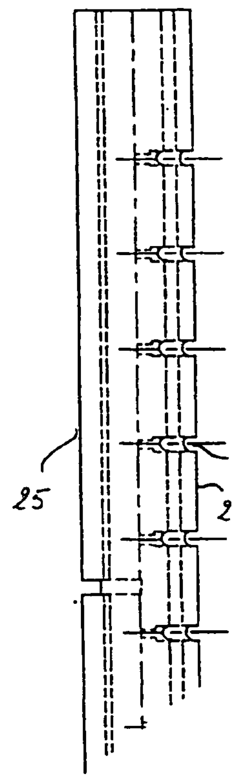

Fig. 4

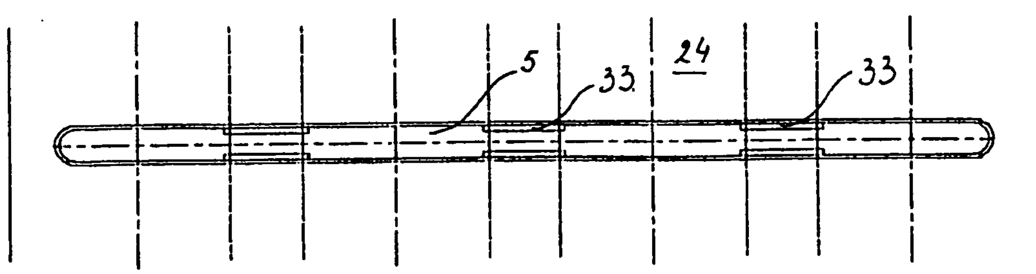

Fig. 5

INTERNATIONAL SEARCH REPORT

In. ational Application No
PCT/EP 97/05985

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F28F9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 608 439 A (MODINE MANUFACTURING CO) 3 August 1994 see column 4, line 14 - column 8, line 42; figures ---	1,2,5,7
X	DE 38 13 339 A (HAPPEL GMBH & CO) 9 November 1989 see column 4, line 34 - column 5, line 56; figures ---	1,5-7
Y	CA 1 117 520 A (NORTH YORK MOBILE WASH) 2 February 1982 see page 6, line 25 - page 12, line 19; figures --- -/--	1,2,4,7

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 February 1998	02/03/1998

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 43 05 060 A (BEHR GMBH & CO) 25 August 1994 see column 2, line 25 - column 4, line 66; figures ---	1,2,4,7
A	US 5 348 081 A (HALSTEAD GARY A ET AL) 20 September 1994 see column 2, line 60 - column 5, line 9; figures -----	

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 97/05985

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